APPENDIX C

AQUATIC SPECIES DESCRIPTIONS

APPENDIX C: AQUATIC SPECIES DESCRIPTIONS

Chinook Salmon

Chinook salmon are found along the Pacific Coast from the Ventura River in southern California to Point Hope, Alaska (Wydoski and Whitney 1979). In Washington, chinook salmon spawn in streams in the Columbia River, Puget Sound, and coastal drainages (Wydoski and Whitney 1979).

Naturally spawning females guard redds for up to three weeks before dying; males attempt to fertilize other redds before dying (U.S. Federal Register, 9 March 1998). Chinook salmon eggs hatch after 90 to 150 days, depending on water temperature (Wydoski and Whitney 1979). Juvenile summer/fall chinook in the Duwamish basin typically rear in the river for several months during the January through July period before migrating to sea. Out migration occurs primarily during the months of April, May, and June. Juvenile fall (ocean-type) chinook salmon use estuaries extensively to feed before starting their long-distance oceanic migrations, exhibiting longer residence times in estuaries than do other anadromous salmonids (Healey 1982).

The following overview (Table C-1) of the habitat requirements for chinook salmon have been derived primarily from *Habitat Requirements of Anadromous Salmonids* (Reiser and Bjornn 1979), and *Habitat Suitability Index Models and Instream Flow Suitability Curves: Chinook Salmon* (Raleigh et al. 1986).

Table C-1
CHINOOK HABITAT REQUIREMENTS

Parameter	Metric Units	English Units
Upstream Migration of Adults		
Temperature Range	10.6-19 ^{o}C	51-67 ^{o}F
Minimum Depth	0.24 meters	9.5 inches
Maximum Velocity	2.44 meters/sec	8.0 feet/sec
Spawning and Incubation		
Temperature Range		
spawning	5.6-13.9^{o}C	42-57^{o}F
incubation	5.0-14.4^{o}C	41-58^{o}F
Minimum Depth	0.24 meters	9.5 inches
Velocity Range	30-91 cm/sec	1-3 feet/sec
Substrate (Gravel) Size Range	1.3-10.2 cm	0.5 - 4 inches
Minimum Dissolved Oxygen	5 mg/l	
Average Redd Area	5.1 square meters	55 square feet

Coho Salmon

Coho salmon are found along the Pacific Coast from Monterey Bay in central California to Point Hope, Alaska (Wydoski and Whitney 1979). In Washington, coho salmon spawn in streams in

the Columbia River, Puget Sound, and coastal drainages (Wydoski and Whitney 1979). Adults spawn in late fall and early winter. Coho salmon eggs hatch after 45 to 60 days, depending on water temperature (Wydoski and Whitney 1979).

Coho juveniles typically rear in fresh water for one year (Groot and Margolis 1991). While in fresh water, juveniles utilize virtually all accessible reaches of their natal stream systems for rearing, including lakes, seasonally wetted areas, off-channel ponds, sloughs, swamps, and their tributaries (Pollard et al. 1997; Bryant et al. 1996; Hartman and Brown 1987; Cederholm and Scarlett 1981; Skeesick 1970). Some physical characteristics of habitat typically selected by coho fry and parr include depths greater than 8 centimeters, low current velocity, and availability of cover (Fransen et al. 1993; Fausch 1993; Shirvell 1990; Bugert et al. 1991). Juvenile coho typically begin migrating to sea as smolts during their second spring, with peak downstream migration typically occurring from April through mid-May.

The following overview (Table C-2) of the habitat requirements for coho salmon has been derived primarily from *Habitat Requirements of Anadromous Salmonids* (Reiser and Bjornn 1979), and *Habitat Suitability Index Models and Instream Flow Suitability Curves: Coho Salmon* (McMahon 1983).

Table C-2
COHO HABITAT REQUIREMENTS

Parameter	Metric Units	English Units
Upstream Migration of Adults		
Temperature Range	7.2-15.6 °C	45-60 °F
Minimum Depth	0.18 meters	7 inches
Maximum Velocity	2.44 meters/sec	8.0 feet/sec
Spawning and Incubation		
Temperature Range		
spawning	4.4-9.4 °C	40-49 °F
incubation	4.4-13.3 °C	40-56 °F
Minimum Depth	0.18 meters	7 inches
Velocity Range	30-91 cm/sec	1-3 feet/sec
Substrate (Gravel) Size Range	1.3-10.2 cm	0.5-4 inches
Minimum Dissolved Oxygen	5 mg/l	
Average Redd Area	2.8 square meters	30 square feet

Chum Salmon[1]

Chum salmon have the largest range of natural geographic and spawning distribution of all the Pacific salmon species (Bakkala 1970). Historically, in North America, chum salmon occurred from Monterey, California to the Arctic coast of Alaska and east to the Mackenzie River, which flows into the Beaufort Sea. Present spawning populations are found as far south as Tillamook Bay on the northern Oregon coast (Johnson et al. 1997).

[1] description from local references and USACE 2002, Appendix B – Species Descriptions

Chum salmon spawn in streams and rivers of various sizes, and the fry migrate to sea soon after emergence. They spend more of their life history in estuaries and marine waters than the other Pacific salmon species with the exception of ocean-type (fall) chinook salmon. Chum salmon spawning runs can be grouped into three seasonal runs; summer, fall and winter.

Chum salmon primarily spawn in the lower reaches of rivers and in shallower, lower gradient, lower velocity streams and side channels, extending from just above tidal influence up to 100 km of the ocean (Salo 1991; Johnson et al. 1997). Some chum salmon may also spawn in intertidal areas, with the presence of upwelling groundwater potentially being a preferred spawning location (Johnson et al. 1997). They typically show little persistence in successfully passing falls or blockages, though there are some exceptions. In some low gradient systems such as the Yukon River in Alaska or the Amur River in the Russian Federation, chums have been documented to migrate up to 2,500 km inland (Johnson et al. 1997).

Fry typically emerge from the gravel at night and immediately migrate downstream to estuarine waters (Salo 1991), although, in some populations, fry may spend a few days to several weeks in the stream and then move downstream to the ocean (Salo 1991; Johnson et al. 1997). Fry outmigration may take only a few hours or days where spawning sites are close to the mouths of rivers (Johnson et al. 1997). In Washington, Oregon and British Columbia, migration to the estuary occurs from February through May with earlier migrations occurring to the south (Johnson et al. 1997). Chum and pink salmon do not have the clearly defined smolt stages that occur in other salmonids, however they are capable of adapting to seawater as fry, soon after emergence from the gravel (Johnson et al. 1997).

Like fall chinook salmon, juvenile chum salmon use estuaries extensively to feed before starting their long-distance oceanic migrations (Healey 1982).

Sockeye Salmon[2]

The most notable distinguishing characteristic of the life history of sockeye salmon is that they almost invariably spend a year or more rearing in a fresh water lake before migrating to sea to grow to maturity (though exceptions are reported). Landlocked forms of sockeye are called kokanee, and typically grow to maturity, at a smaller size, in lake environments. Sockeye salmon occur in North America from the Columbia River, Washington to the Nome River, Alaska (Gustafson et al. 1997).
The prevalent lake-type sockeye salmon spawn primarily in inlet or outlet streams of lakes or along lake shorelines with clean gravel substrate and groundwater upwelling or wind driven currents that supply egg oxygenation (Foerster 1968; Burgner 1991; Gustafson et al. 1997; NMFS 1998). After emergence in streams sockeye fry move either upstream or downstream to rearing lakes, this migration typically occurs at night to avoid predators (Gustafson et al. 1997).

Residence time in the lake is influenced by growth. Growth is influenced by interspecific and intraspecific competition, food supply, water temperature, thermal stratification, migratory movement to avoid predation, lake turbidity, and length of growing season (Gustafson et al. 1997). In Washington State and British Columbia, lake residence time is normally one to two years (Burgner 1991). Lake-type sockeye salmon smolt and migrate to sea in the spring, and

[2] description from USACE 2002, Appendix B – Species Descriptions

spend one to four years in the marine environment and return to their natal lake system to spawn in the late summer or early autumn (Gustafson et al. 1997). While migrating upstream, sockeye salmon take advantage of slower water and eddies along streambanks and bottoms, and travel in schools (Burgner 1991).

In the Puget Sound area, sockeye typically migrate upstream in July through August and may spend some time in lakes before spawning in October and November. Emergence and downstream migration to a lake environment occurs primarily during March and April (WDF et al. 1975).

Pink Salmon

Pink salmon invariably have a two-year life history, and thus individual stocks are typically identified as "even-year" or "odd-year" with essentially no cross breeding between the two types of stocks. In Washington, nearly all pink salmon are odd-year spawners (1999, 2001, 2003, 2005, etc.), although a small even-year stock is found in the Snohomish River (WDF et al. 1993). Even-year stocks generally become more prevalent to the north, in British Columbia and Alaska, with some areas having significant runs of both even- and odd-year stocks. In Washington, adult pink salmon migrate upstream to spawn in rivers and larger streams primarily in August and September with spawning occurring mostly during September and October. Fry migrate to sea immediately after emergence during the months of March, April, and, to a lesser extent, May (WDF et al. 1975; Wydoski and Whitney 1979).

Cutthroat Trout[3]

Coastal cutthroat trout occur along the coast of North America from Humboldt Bay, California to Prince William Sound, Alaska. This subspecies occurs inland to the crest of the Cascade Mountain Range in Washington and Oregon, and to the crest of the Coast Range in British Columbia and Alaska (Trotter 1989).

There are three basic life history forms that occur amongst the various coastal cutthroat trout populations, including an anadromous form, a potamodromous form that includes both stream-dwelling and lake dwelling populations, and a non-migratory form that resides in small streams and headwater tributaries (Trotter 1989).

The anadromous life history form of coastal cutthroat trout spawn in low or gentle gradient areas of the mainstem or tributaries of small to moderate size streams systems (Trotter 1989). Spawning periods extend from December through May with peak spawning periods in February in Washington, Oregon and southern British Columbia (Trotter 1989). Emergence from the gravel can occur from March through June, with a peak occurring around mid April (Trotter 1989). After emergence, cutthroat trout need nursery and rearing habitat with protective cover and low velocity water (Behnke 1992). These habitats occur along stream margins, side channels, small tributaries and spring seeps.

Anadromous coastal cutthroat trout have been documented to smolt and migrate to sea from age 1 to age 6 (Giger 1972; Lowery 1975), with the majority smolting and migrating at age 2, 3, or 4 (Trotter 1989). In Washington and Oregon, seaward migration peaks in mid-May (Trotter

[3] description from USACE 2002, Appendix B – Species Descriptions

1989). Anadromous coastal cutthroat trout spend two to five months in bays, estuaries, and along the coast before returning to the rivers as the winter months approach (Behnke 1992). Anadromous coastal cutthroat trout may complete this seaward migration pattern twice before they return to the river to spawn (Trotter 1989). They feed on crustaceans and fish when in salt water and on the drifting larvae of aquatic insects or other fish species when in fresh (Behnke 1992).

Resident non-migratory coastal cutthroat trout populate small headwater streams and exhibit only limited instream movement (Trotter 1989). These fish are small, not reaching a length greater that 150 to 200mm (6-8 inches), and their life span is shorter, typically living until three to four years in age (Wyatt 1959). Resident coastal cutthroat trout mature at age two to three (June 1981; Nicholas 1978).

After emergence from the gravel, young fish move to channel margins, side channels, and slow water areas (Moore and Gregory 1988). At the end of the summer, they move to feeding stations in pools (Moore and Gregory 1988). In winter, they may move downstream to more secure winter habitats. Wyatt (1959) reported that only 3 percent of the population ever moved more than 200 m from their emergence area. In the spring, when water temperatures reach 5 to 6^{o}C, mature resident non-migratory coastal cutthroat trout move back into spawning areas. Resident life history forms primarily feed at the head of pools on drift prey (Wilzbach and Hall 1985).

Steelhead Trout[4]

Steelhead trout (*Oncorhynchus mykiss*) are found from central California to the Bering Sea and Bristol Bay coastal streams of Alaska. Most streams of any size in the Puget Sound region have populations of steelhead trout (Pauley et al. 1986).

In Washington coastal populations, total age at maturity is typically four years; two years in freshwater and two years in the ocean.

Steelhead have two basic reproductive ecotypes, based on the state of their sexual maturity at river entry and the durations of the spawning migration (Burgner et al. 1992). These reproductive ecotypes are 1) stream maturing or summer steelhead, or 2) ocean maturing or winter steelhead (Busby et al. 1996). Some basins, such as the Duwamish/Green River, have both summer and winter steelhead present. Where they both occur, they are often separated by a seasonal hydrologic barrier such as a waterfall (Busby et al. 1996). It appears summer steelhead occur where habitat is not fully used by winter steelhead, and summer steelhead spawn further upstream than winter steelhead (Withler 1966; Roelofs 1983; Behnke 1992).

Summer steelhead enter fresh water from May to October in a sexually immature state, migrate upstream during the spring and summer, and hold in areas of protected cover such as deep pools, undercut banks, overhanging vegetation or large woody debris or boulder structures until they become sexually mature. These summer steelhead do not spawn until the following spring (Pauley et al. 1986), so they hold over the fall and winter in freshwater.

[4] description from USACE 2002, Appendix B – Species Descriptions

Winter steelhead enter their home stream in various stages of sexual maturation from November to April (Pauley et al. 1986). Winter steelhead are the more widespread of the two reproductive types.

After hatching and emergence, steelhead move to deeper parts of the stream, establish territories and diet changes from microscopic aquatic organisms to larger organisms such as isopods, amphipods and aquatic and terrestrial insects, primarily associated with the stream bottom (Wydoski and Whitney 1979). During rearing, streamside vegetation and submerged cover (logs, rocks, and aquatic vegetation) are important. Cover provides food, temperature stability, protection from predators, and densities of juvenile steelhead are highest in areas containing instream cover (Narver 1976; Reiser and Bjornn 1979; Johnson 1985). Juvenile steelhead remain in fresh water for one to four years before smoltification and subsequent migration to sea. Steelhead typically remain in the ocean for two to three years, but may occasionally remain for four years prior to their first spawning migration (Shapolov and Taft 1954).

Bull Trout

Several thorough reviews of bull trout literature were surveyed in preparation for this species description. The following is a summary of the salient points from those reviews cited collectively, with information from other sources cited separately. The collective citation for the bulk of this description follows: Brown (1992), Rieman and McIntyre (1993), and Sanborn et al. (1998).

The historical range of bull trout extended from the McCloud River in California to the Yukon River in Alaska, west of the Continental Divide within the contiguous United States except in tributaries of the Saskatchewan River, but east of the Continental Divide in the Saskatchewan and Mackenzie River systems in Canada. In Washington, bull trout occur within the Columbia River system, in most rivers of Puget Sound, and in coastal rivers from Grays Harbor north (U.S. Federal Register, 1 November 1999).

Several life history forms of bull trout occur, and all may be present within the same population. Fish exhibiting the resident life history strategy are non-migratory, spending their entire lives within their spawning stream. Migratory life history strategies include fluvial, adfluvial, and anadromous. Migratory bull trout reside as adults and subadults in larger rivers (fluvial), lakes or reservoirs (adfluvial), or marine waters (anadromous), and spawn and rear as juveniles in headwater tributaries. Anadromous forms are common in Puget Sound drainages from the Snohomish River north (Kraemer in prep.).

The majority of bull trout spawning occurs between late August and early November. Spawning migrations occur during the summer, but may start as early as April in some systems (Ratliff et al. 1996). In river systems of north Puget Sound, spawners typically arrive in holding areas near spawning grounds from several weeks, to up to four months before spawning (Kraemer in prep.). Characteristics of holding areas are: depth of at least one meter; cover in the form of turbulent water, undercut banks, woody debris, or overhanging vegetation; and cool temperatures, often provided by groundwater input. Spawning typically does not commence until stream temperatures drop to 8°C. In the North Puget Sound region, “the downstream limit of successful spawning is always upstream of the winter snow line (that elevation at which snow is present on the ground for much of the winter)” (WDFW 1999). Bull trout spawning habitat

typically consists of gravel/cobble substrates (Kraemer in prep.). Once sexually mature, resident, fluvial, and anadromous bull trout in north Puget Sound spawn annually (Kraemer in prep.). Following spawning, adult bull trout move downstream quickly, remaining in deep pools in larger rivers, or in lakes for the winter. Spawned-out bull trout have been observed in November feeding on loose eggs in salmon spawning grounds (Kraemer in prep.).

Successful egg incubation for bull trout requires temperatures less than 5°C (WDFW 1999), with maximum survival between 2 and 4°C. Incubation usually takes from 100 to 145 days, depending on temperature. Both juvenile and adult bull trout are rarely found in streams with summer temperatures that exceed 15°C, though cold groundwater seeps can occasionally provide temperature refuges that allow bull trout to inhabit the warmer streams. Fry are closely associated with the substrate while foraging, and rely on interstitial spaces for cover. Bull trout juveniles show a preference for low-velocity habitat; fry are often found in backwater areas, stream margins, and side channels, while larger juveniles occupy pools. Juveniles disperse widely from the spawning area, and should be expected even in tributaries that do not support spawning unless access is obstructed by a passage barrier. Juveniles that adopt a migratory life history strategy usually move downstream to a mainstem river, lake, or ocean following two or three years of rearing in headwater streams. The timing of this migration varies between and within systems, and is not confined to spring. The non-spawning movements of adults are generally associated with thermal requirements, either seeking warmer water in winter (non-coastal populations) or colder water in summer.

Anadromous bull trout spend two to three years in fresh water before migrating in the spring to the estuary or nearshore marine environment (Kraemer in prep.). While in the marine environment, they feed on smaller fish such as surf smelt (*Hypomesus pretious*), Pacific herring (*Clupea harengus pallasi*), Pacific sand lance (*Ammodytes hexapterus*), and pink (*O. gorbuscha*) and chum (*O. keta*) salmon fry, closely following the distribution of the prey fish (Kraemer in prep.). Subadults usually spend two summers in the marine environment before they mature, separated by a return to fresh water to overwinter, and immature and non-spawning adult fish migrate upstream with the spawners in late summer (Kraemer in prep.).

River Lamprey

The river lamprey is found in coastal streams from northern California to southeastern Alaska. In Washington, this species is expected to occur in most major rivers. These fish are anadromous and are parasitic on other fishes, including salmonids. They spawn in sandy and gravelly riffle areas, similar to salmonids, but on a smaller scale, since they are snake-like in shape and typically only 12 inches long at maturity. They spawn in the spring. After hatching, their young spend an extended period buried in the silt and sand of stream eddies where, blind and toothless, they feed on algae and microbes. Their eyes and teeth become functional when they reach a length exceeding approximately 4.6 inches, after which they migrate to sea to feed, grow, and mature (Wydoski and Whitney 1979).

Pacific Lamprey

The Pacific lamprey is found in coastal streams from southern California to the Gulf of Alaska. In Washington, it is found in most coastal rivers. Like the river lamprey, they are anadromous, their adults are parasitic on other fishes, and their larval juveniles are filter feeders which grow in the silty substrates of stream eddies and backwaters. Also, like the river lamprey, they spawn in gravelly riffle areas in the spring. Pacific lampreys are larger, however, and may reach a length of 30 inches and weigh up to 1 pound. Like Pacific salmon, they die after spawning. Larval juveniles may spend up to six years in fresh water before migrating to sea (Wydoski and Whitney 1979).

Sand Lance[5]

The sand lance (*Ammodytes hexapterus),* also known locally as the "candlefish," is an ecologically important forage fish throughout Puget Sound, providing food for young salmon. Approximately a third of the food eaten in the nearshore waters by juvenile salmon consists of sand lance, and juvenile chinook salmon depend on sand lance for 60 percent of their diet. Minke whales, other marine mammals, and many species of seabirds also prey on sand lance.

Sand lance spawning typically occurs at high tide in shallow water on sandy or gravelly beaches. On many gravel beaches, the eggs of winter-spawning surf smelt stocks and sand lance may be found incubating together in the same sediments. At the moment of spawning, sand lance eggs often take on a coat of attached sand grains making them nearly invisible, which may explain why sand lance spawning activity went unnoticed on Puget Sound beaches until recently. After hatching, larval sand lances enter the plankton, and are common in many bays and inlets in Puget Sound during the late winter and spring. Juvenile sand lances rear in nearshore waters along Puget Sound during the summer.

Because sand lance spawn in the intertidal zone of the Puget Sound shoreline, local spawning populations are vulnerable to shoreline development. Construction of bulkheads and other shoreline armoring can bury the upper intertidal zone. Bulkheads and other armoring may also damage spawning habitat by causing increased erosion and interruption of sediment transport. The spawning habitat of sand lance is considered a "marine habitat of special concern" in the Washington Administrative Code (WAC) Hydraulic Code Rules. In cases where no satisfactory redesign or mitigation is possible, a Hydraulic Permit may be denied.

Surf Smelt[6]

Surf smelt (*Hypomesus pretiosus*) are a schooling fish found in shallow nearshore waters along Puget Sound. Adult surf smelt feed on plankton and in turn become food for seabirds, marine mammals, and a variety of fishes including salmon. Surf smelt spawn in the upper intertidal zones of mixed sand and gravel beaches, generally within a few feet of the high tide line. Spawning takes place year round on beaches along Whidbey Island, Camano Island,

[5] description from Washington Department of Ecology website, http://www.ecy.wa.gov/programs/sea/pugetsound/species/sandlance.html.

[6] description from Washington Department of Ecology website, http://www.ecy.wa.gov/programs/sea/pugetsound/species/smelt.html.

Semiahmoo Bay, Cherry Point, Fidalgo Bay, Sinclair Inlet, the San Juan Islands, and the outer coast of the Olympic peninsula. Fall and winter spawning occurs along Liberty Bay, Port Orchard, Quartermaster Harbor, southern Hood Canal, and southern Puget Sound. Summer spawning occurs along the Strait of Juan de Fuca.

Over 200 miles of surf smelt spawning beaches are known to exist along Puget Sound. Surf smelt spawning beaches are often located at the heads of bays or inlets shaded by trees and bluffs. Shade moderates beach surface temperatures and helps summer-spawned eggs survive to hatching. Many sand and gravel beaches have yet to be surveyed for evidence of surf smelt spawning activity. Ripening surf smelt move in close to the water's edge at high tide for spawn deposition. Adhesive eggs about 1 millimeter in diameter are laid on the surface of the beach. Subsequent wave action covers the eggs with beach sediments. Larval surf smelt enter the nearshore plankton after hatching. Juvenile surf smelt linger and feed in shallow waters throughout Puget Sound. The majority of spawning surf smelt are two years of age, with some males maturing at one year of age. Although surf smelt do not die after spawning, very few survive to be three or four years old. Surf smelt show great annual predictability in spawning sites and seasons, but the degree to which they "home" back to their beaches of their birth is unknown.

All known surf smelt spawning sites have been given enhanced "no net loss" protection in the application of Washington Administrative Code (WAC) "Hydraulic Code Rules."

Geoduck[7]

The geoduck (Panopea abrupta) is the largest bivalve in North America, and one of the world's largest clams, averaging about 2 pounds but ranging up to 14. Geoducks are found along the Pacific Coast from California to Alaska, and harvested primarily in the inland waters of Washington, British Columbia, and Alaska. They reach maturity at between three and five years of age, but the oldest known geoducks are more than 165 years old. They live at and below the low tide line, dug into the bottom sediments (sand, mud, and gravel) for protection, since they are generally too large to fit into their shells at maturity.

Geoducks have been harvested commercially since 1970, from depths between 18 and 70 feet, managed closely by the Washington Departments of Fish and Wildlife and Natural Resources. The shoreward harvest boundary is generally deep enough to protect sensitive nearshore habitats, such as eelgrass beds and forage fish spawning areas. According to WDFW estimates, the total geoduck biomass in Washington State could be as high as 674 million pounds. Beds to be harvested are selected by DNR from those that have been designated as harvestable by WDFW, and certified by The Department of Health. Many otherwise pristine areas cannot be harvested because of non-point pollution that seeps into the waters from such sources as septic systems, roads, and storm drains. Thus, a real and potential impact of on-shore development is a reduction in the areas certifiable for commercial geoduck harvest, as well as any reduction in productivity as a result of decreased water quality.

[7] description from Washington DNR web site
http://www.wa.gov/dnr/htdocs/adm/comm/fs02-136.htm